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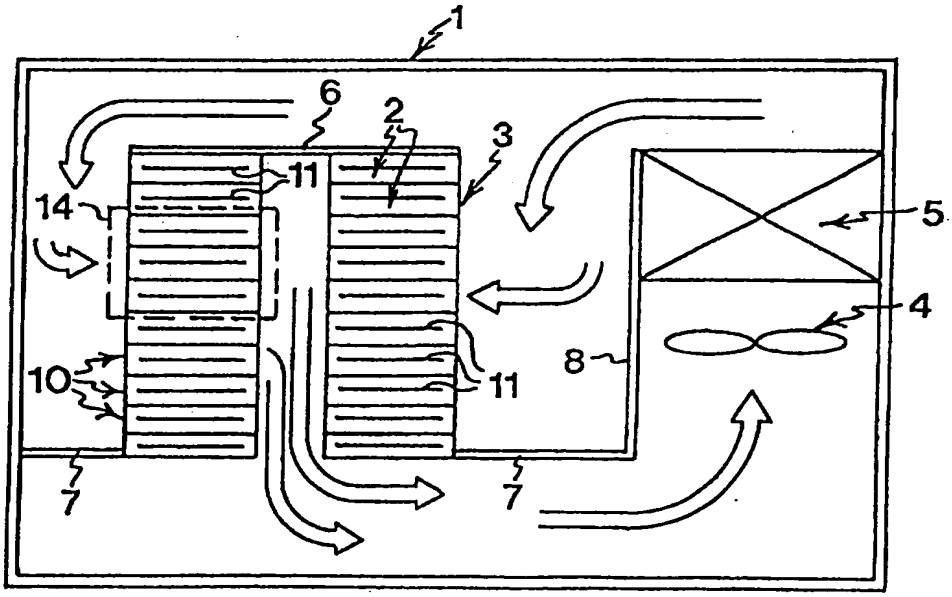
(57) Abstract

An apparatus for treatment of products with gas comprises a housing (1), a fan (4) for circulating treating gas in the housing, and a conveyor belt (2) having a foraminous product-carrying base (11) for moving the products through the housing, said conveyor belt following, along part of its length, a helical path in the housing. A duct (10) of subtantially rectangular cross section and of the same helical shape as the helical path of the conveyor belt (2) accommodates the conveyor belt in the helical path thereof, with the product-carrying base (11) positioned between the bottom and top of the duct. The bottom and top of the duct are closed, and the duct has a closure on its one side above and, on its other side, below the product-carrying base. Otherwise, the sides of the duct are gas-permeable. Means (6-8) are arranged for guiding the gas flow in the radial direction relative to a hollow cylinder formed of the duct, such that the gas flow passes through this via the foraminous product-carrying base of the conveyor belt in series with the gas-permeable parts of the sides of the duct adjacent to the product-carrying surface.



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APPARATUS FOR TREATMENT OF PRODUCTS BY GAS

The present invention relates to an apparatus for treatment of products with gas and preferably treatment of food products or the like with air.

The inventive device comprises more specifically a housing, a fan for circulation of treating gas in the housing, and a conveyor belt having a foraminous product-carrying base for moving the products through the housing, said conveyor belt following, along part of its length, a helical path in the housing. The conveyor belt forms a belt stack in the form of a hollow cylinder.

Such conveyor belts are disclosed in e.g. US-A-3,938,651, 4,603,776 and 4,941,567, said conveyor belts being such that a superjacent conveyor belt part is directly supported by a subjacent conveyor belt part. Other examples of conveyor belts of the type involved are disclosed in US-A-3,225,893, 3,261,451 and 4,875,343, said conveyor belts being supported by separate supporting rails at least along their one side.

The gas flow used for treatment of the products can be contacted with the products in various ways.

A first technique is the directing of the flow vertically through the belt stack, i.e. substantially perpendicular to the product-carrying base of the conveyor belt, which base must be gas-permeable, for instance foraminous like a net or the like. This results in a good interaction between the gas and the products, in which the gas will pass through the conveyor belt turn after turn and its properties will be affected by interaction with the products, such that these are exposed to a gas having different properties in different parts of the belt stack. The change of the properties can be desirable, but it is also possible that the effect of the products on the gas gradually gives the gas undesired properties, for instance an unsuitable temperature or moisture content. A further drawback of this flow pattern

is that a relatively great pressure drop arises over the belt stack and, thus, that undesiredly great differences in pressure will arise in the housing.

A second technique is to direct the flow radially through the belt stack, i.e. in the lateral direction of the conveyor belt. As a result, the pressure drop will be relatively small and the products in the entire stack can simultaneously be exposed to gas having one and the same property, but there is a risk that the interaction between the gas and the products decreases compared with the case involving a vertical flow.

A third and normally undesired technique is to direct the flow so as to follow the conveyor belt in the longitudinal direction thereof. In this case, the drawbacks of the first and the second technique of directing the flow are in fact combined. Thus, the properties of the gas change gradually while passing through the belt stack, and the interaction between the gas and the products will be relatively weak.

The object of the present invention is to provide an apparatus of the type mentioned by way of introduction, said device conferring the advantages of the first technique of directing the flow without causing the drawbacks thereof.

According to the invention, this object is achieved by an apparatus according to the accompanying claim 1. Preferred embodiments of this apparatus are defined in the dependent claims.

What characterises the inventive apparatus thus is that it employs a duct of substantially rectangular cross-section and of the same helical shape as the helical path of the conveyor belt. This duct should have a closed bottom and a closed top. These can be the same, i.e. the bottom of one turn of the duct can constitute the top of a subjacent turn.

The duct further accommodates the conveyor belt in the helical path thereof, with the product-carrying base

positioned between the bottom and the top. Finally, the duct has a closure on its one side above and on its other side below the product-carrying base, whereas otherwise the sides of the duct are gas-permeable.

As a result of the above described construction, gas which is conducted radially towards one side of the duct will pass in the radial direction in through the gas-permeable part of this side, then pass essentially vertically through the product-carrying base and finally leave in the radial direction through the gas-permeable part of the other side of the duct.

Thus, the gas flow can through each turn of the belt stack be connected, for instance, in parallel with the gas flow through every other turn of the belt stack, but all the same be directed vertically through the product-carrying base of the conveyor belt. The gas flow can, of course, be directed radially inwards or radially outwards through the hollow cylinder of the belt stack. Also, the gas flow can be directed vertically upwards or downwards through the product-carrying base.

By arranging a plurality of gas flow ducts, which open into predetermined areas or portions of the outside and/or inside of the belt stack, these portions can be connected in series and/or in parallel in any desired manner. In each duct, the gas can further be conditioned in the manner which is most suitable for treatment of the products within the associated portion.

In a preferred embodiment, the duct is accomplished by means of two conveyor belts, viz. on the one hand the product-moving conveyor belt, which has a lateral portion forming the lateral closure of the helical duct above the product-carrying base of the same conveyor belt and, on the other hand, a second conveyor belt interleaved with the product-moving conveyor belt and thus following a helical path of the same helical shape as the product-moving conveyor belt, said second conveyor belt forming the bottom, top and lateral closure of the duct below the

product-carrying base. In this preferred embodiment, each conveyor belt supports a superjacent part of the other of the conveyor belts in the same manner as shown in e.g. US-A-5,031,751.

Alternatively, the bottom, top and sides of the duct can be stationary. Then the product-moving conveyor belt can have at least one gas-permeable lateral portion. If it has a single portion of this type, this should suitably be positioned on the same side of the duct as the closure of the duct below the product-carrying base of the conveyor belt.

However, it is also possible that the lateral closure of the duct above the product-carrying base constitutes part of the conveyor belt and, thus, is movable together with this.

The invention will now be described in more detail with reference to the accompanying drawings, in which

Fig. 1 is a perspective view of a prior-art type apparatus, where the present invention is applicable,

Fig. 2 is a schematic cross-section illustrating the principle of the present invention,

Figs 3-9 illustrate schematically different embodiments of a helical duct, which is included in the inventive apparatus, and

Figs 10-11 show different embodiments of guidings of the gas flow in an apparatus according to the present invention.

The apparatus described below preferably use air as treating gas, but the invention is not limited to this. They are first of all intended for freezing food products, which however is also not to be considered limiting to the invention. Thus, the apparatus can use such gases as, for instance, carbon dioxide and nitrogen, it can treat other products than food products, and the treatment can imply something else than freezing, e.g. cooling, heating, frying and drying.

The prior-art apparatus shown in Fig. 1 comprises a housing 1, in which a conveyor belt 2 is arranged to follow, along part of its length, a helical path and thus form a belt stack 3 in the form of a hollow cylinder. A fan 4 is arranged for circulating air through the apparatus, a cooling coil 5 giving the air the desired temperature.

Although the conveyor belt 2 is endless, its path outside the housing 1 is not shown in Fig. 1.

The schematic cross-section in Fig. 2 shows the housing 1, the belt stack 3, the fan 4 and the cooling coil 5. Fig. 2 also shows partitions 6, 7 and 8, which guide the circulation of the air flow. As indicated by arrows in Fig. 2, the air circulates more specifically radially through the belt stack 3 from its outside to its inside so as then to return to the outside via the fan 4 and the cooling coil 5.

According to the invention, the belt stack 3 is formed more specifically of a helical duct 10 of substantially rectangular cross-section. The duct 10 is of the same helical shape as the helical path of the conveyor belt 2 so as to accommodate the conveyor belt 2 in the helical path thereof, with a product-carrying base 11 of the conveyor belt 2 positioned between the bottom 12 and the top 13 of the duct 10, said base 11 preferably being flat and having an essentially flat surface, on which the products should rest.

With a view to illustrating various embodiments of the duct 10, a portion 14 framed by dashed lines in Fig. 2 is illustrated on a larger scale in Figs 3-9. The framed portion comprises three superposed turns of the duct 10. In Figs 3-9, double lines represent a substantially gas-impermeable surface, whereas a gas-permeable surface is represented by a single line. The three turns of the duct 10 within the frame 14 are indicated by dashed lines in Figs 3-9.

In the embodiment according to Fig. 3, the duct 10 is stationary and has a gas-impermeable bottom 12 and top 13. As appears from the Figure, a bottom 12 can at the same time constitute the top 13 of a subjacent turn of the duct 10. The duct 10 further comprises a closure 15 on its one side above the product-carrying base 11 of the conveyor belt 2, and a closure 16 on its other side below the product-carrying base 11. The conveyor belt, which essentially consists but of the product-carrying base 11, is arranged on helically extending supporting rails 17. The air flow through the duct 10 is illustrated by arrows.

The embodiment of the inventive apparatus shown in Fig. 4 conforms with the one in Fig. 3, with the only difference that the conveyor belt 2 in Fig. 4 has lateral portions 18 and 19 for safe retaining of the products on the conveyor belt 2. The lateral portion 18 can optionally be excluded. The lateral portion 19 must be gas-permeable, e.g. foraminous.

In the embodiment of the inventive apparatus shown in Fig. 5, the duct 10 comprises, as before, a gas-impermeable bottom 12 and top 3, as well as the gas-impermeable closure 16 below the product-carrying base 11. In this embodiment, however, the gas-impermeable closure 15 is not stationary, i.e. not connected to the top 13, but instead constitutes part of the conveyor belt and is connected to the product-carrying base 11 at one lateral edge thereof. The closure 15 thus constitutes a lateral portion of the conveyor belt 2. Like in Figs 3 and 4, the conveyor belt 2 in Fig. 5 is arranged on helical supporting rails 17.

The embodiment of the inventive apparatus as shown in Fig. 6 conforms with the one in Fig. 5, except that the conveyor belt in Fig. 6 has the gas-permeable lateral portion 19 at the side of the conveyor belt 2 opposite the closure or lateral portion 15.

In the embodiments of the inventive apparatus shown in Figs 7-9, the duct 10 is formed of, on the one hand, the conveyor belt 2 and, on the other hand, a second conveyor belt 20, which forms both the bottom 12 and top 13 of the duct 10.

In the embodiment according to Fig. 7, the second conveyor belt 20 thus forms the gas-impermeable bottom 12 and top 13 of the duct 10 and also the gas-impermeable closure 16 at one side of the duct 10 below the product-carrying base 11. The conveyor belt is here designed as in Fig. 5 and thus constitutes the gas-impermeable closure 15 of the duct 10 above the product-carrying base 11. In this embodiment, the two conveyor belts 2 and 20 can be supported each by stationary, helical rails 17 and 21, respectively, but alternatively the conveyor belt 2 can support the conveyor belt 20 at one side thereof by means of the closure or lateral portion 15, and the conveyor belt 20 can support the conveyor belt 2 at the other side via its closure 16, which thus constitutes a lateral portion of the conveyor belt 20.

The embodiment of the apparatus according to the present invention shown in Fig. 8 conforms with the one in Fig. 7, except that the second conveyor belt 20 at its side opposite the closure or lateral portion 16 has a gas-permeable lateral portion 22. In this embodiment, the conveyor belt 2 can thus be completely supported by the conveyor belt 20 via the gas-impermeable lateral portion 16 and the gas-permeable lateral portion 22 thereof.

The embodiment of the inventive apparatus shown in Fig. 9 is the preferred embodiment and conforms with the embodiment shown in Fig. 8, with the only difference that also the conveyor belt 2 is designed as shown in Fig. 6, i.e. a gas-permeable lateral portion 19 at the side opposite the gas-impermeable lateral portion 15. In this embodiment, the conveyor belt 2 supports a superjacent part of the second conveyor belt 20, which in turn supports a superjacent part of the conveyor belt 2. Thus,

there is no need for separate supporting rails for the forming of the belt stack 3.

As is evident from Figs 3-9, air conducted radially towards one side of the duct 10 will pass in the radial direction in through the gas-permeable part of this side, then pass substantially vertically through the product-carrying base 11 and finally pass in the radial direction out through the gas-permeable part of the other side of the duct 10. All turns of the belt stack can thus be said to be connected in parallel in this case.

The inventive apparatus, however, permits many combinations of connections in parallel and in series of different portions of the duct 10 in the belt stack 3. As illustrated in Fig. 10, a plurality of gas flow ducts 23 can thus form means for guiding the gas flow and comprise gas-tight shields 24, which are positioned in the radial plane extending through the hollow cylinder or stack 3 and are connected to the outside or inside thereof. Air is supplied through the gas flow ducts 23 to the various portions of the duct 10, and each gas flow duct 23 can comprise its own gas conditioning unit 25, such that air having suitable properties, for instance a certain temperature, can be supplied to the respective portion of the duct 10 in the belt stack 3. On the side of the cylinder or stack 3 opposite the shields 24, there is a collecting conduit 26 extending to the fan 4, from which the air is in turn conducted to the conditioning units 25 of the various flow ducts 23.

Fig. 11 illustrates a further embodiment of means for guiding the gas flow, where a common conditioning unit 27 is used in an inlet duct 28 of a portion of the duct 10, which portion may comprise several turns of the duct 10. By means of transfer ducts 29, the air flow is then conducted in series through different portions of the duct 10 so as to be returned to the fan 4.

It will be appreciated that it is thus possible in the inventive apparatus to connect areas or portions of

the helical duct 10 in series and/or in parallel with each other. The areas or portion connected in series can then be relatively positioned in co-current or counter-current flow or even alternatingly in co-current and countercurrent flow seen in the product-moving direction of the conveyor belt 2. The conveyor belt 2 can, of course, also move either upwards or downwards in the stack 3.

It is also possible to form a plurality of separate flow paths, each having a fan and a conditioning unit by using separate gas flow ducts, which are connected each to a portion of the helical duct 10.

It will be appreciated that several modifications of the above-described embodiments of the inventive apparatus are conceivable within the scope of the invention as defined in the appended claims.

CLAIMS

1. An apparatus for treatment of products with gas, comprising a housing (1), a fan (4) for circulation of treating gas in the housing, and a conveyor belt (2) having a foraminous product-carrying base (11) for moving the products through the housing, said conveyor belt following, along part of its length, a helical path in the housing, c h a r a c t e r i s e d

by a duct (10) of substantially rectangular cross-section and of the same helical shape as the helical path of the conveyor belt (2) for accommodating the conveyor belt in the helical path thereof, with the product-carrying base (11) positioned between the bottom (12) and top (13) of the duct,

the bottom and top of the duct being closed,

the duct having a closure (15; 16) on its one side above and, on its other side, below the product-carrying base, and

otherwise the sides of the duct besides being gas-permeable, and

by means (6-8) for guiding the gas flow in the radial direction relative to a hollow cylinder formed of the duct, such that the gas flow passes therethrough via the foraminous product-carrying base of the conveyor belt in series with the gas-permeable parts of the duct sides adjacent to the product-carrying surface.

2. The apparatus as claimed in claim 1, c h a r - a c t e r i s e d in that the bottom (12), top (13) and sides (15, 16) of the duct are stationary.

3. The apparatus as claimed in claim 2, c h a r - a c t e r i s e d in that the conveyor belt (2) has at least one gas-permeable lateral portion (18, 19).

4. The apparatus as claimed in claim 1, c h a r - a c t e r i s e d in that the lateral closure (15) of the duct above the product-carrying base (11) is part of the

conveyor belt (2) and thus is movable together with the conveyor belt.

5. The apparatus as claimed in claim 4, characterised by a second conveyor belt (20), which is interleaved with the product-moving conveyor belt (2) and which is movable together with the product-moving conveyor belt and forms the bottom, top and lateral closure (16) of the duct (10) below the product-carrying base (11).

6. The apparatus as claimed in claim 5, characterised in that the product-moving conveyor belt (2) has a gas-permeable lateral portion (19) on the side opposite its lateral closure (15).

7. The apparatus as claimed in claim 5, characterised in that the second conveyor belt (20) has a gas-permeable lateral portion (22) on the side opposite its lateral closure (16).

8. The apparatus as claimed in claim 7, characterised in that each conveyor belt (2; 20) supports a superjacent part of the other of the conveyor belts (20; 2).

9. The apparatus as claimed in any one of claims 1-8, characterised in that the means for guiding the gas flow comprise gas-tight shields (24), which are positioned in the radial plane extending through the hollow cylinder (3) and are connected to at least one of the outside and inside thereof for supplying gas having different properties to different parts of the product-moving conveyor belt (2).

10. The apparatus as claimed in claim 9, characterised in that the means for guiding the gas flow comprise a plurality of gas flow ducts (23) for connecting portions of the helical duct (10) in series and/or in parallel with each other.

11. The apparatus as claimed in claim 9, characterised in that the means for guiding the gas

flow comprise a plurality of separate gas flow ducts each for connection to a portion of the helical duct (10).

FIG.1

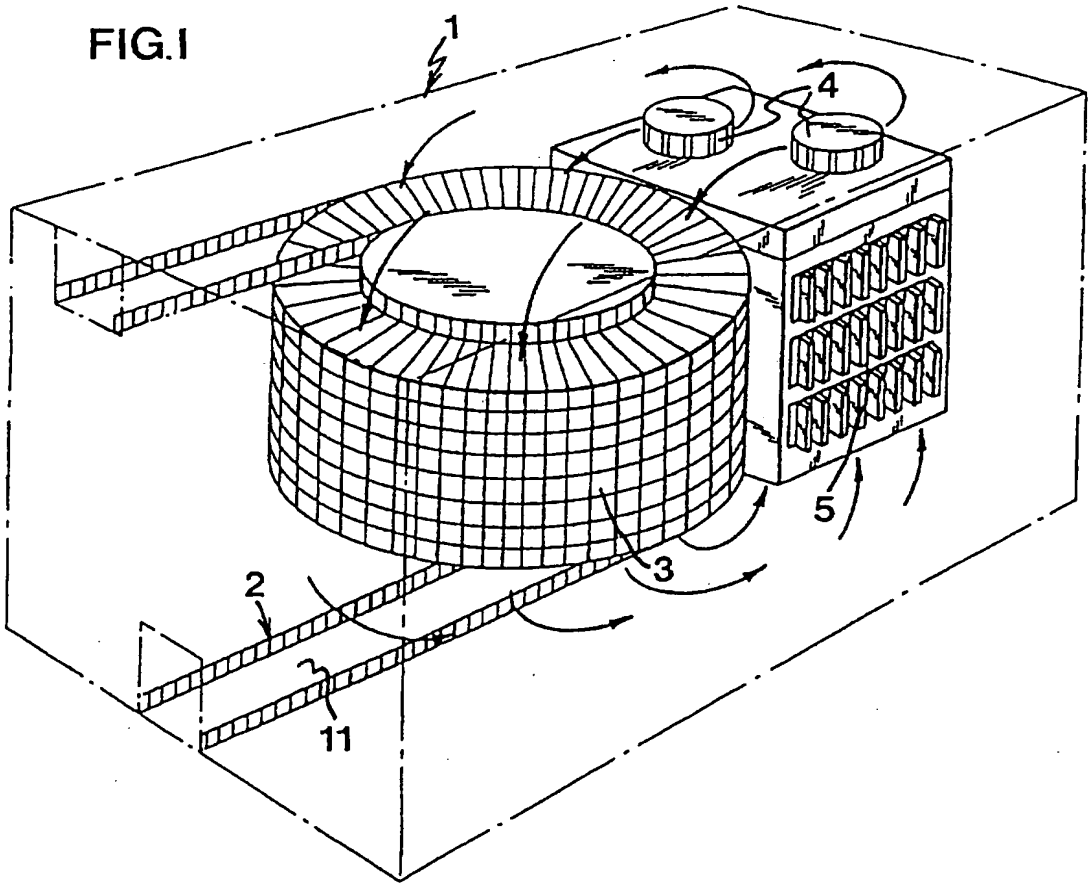


FIG.2

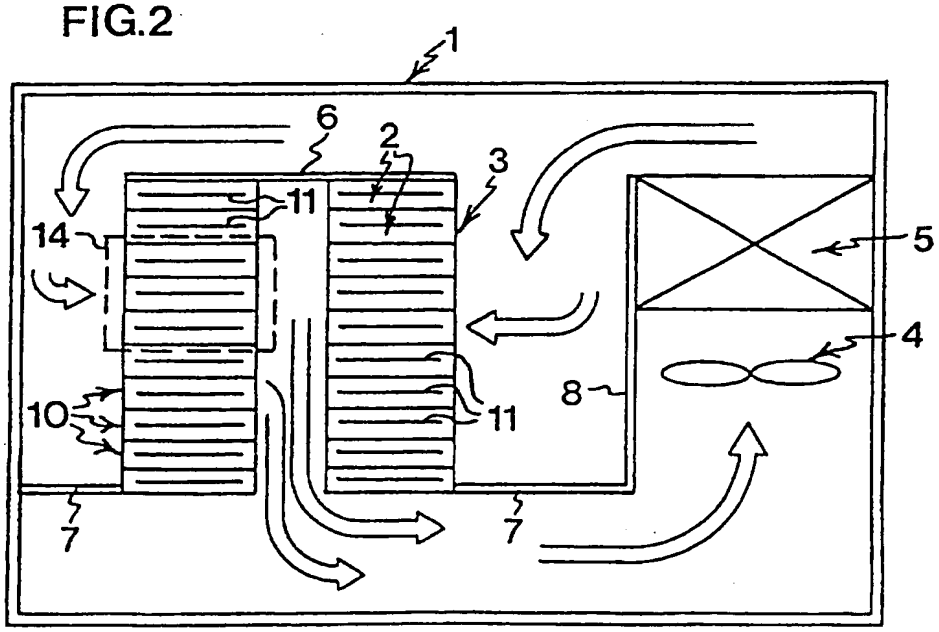


FIG.3

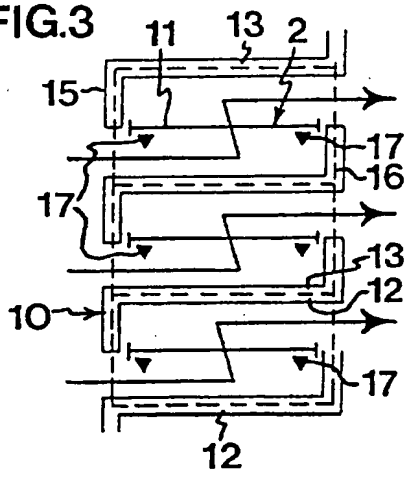


FIG.4

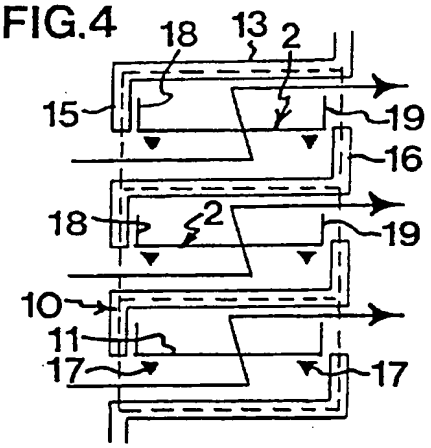


FIG.5

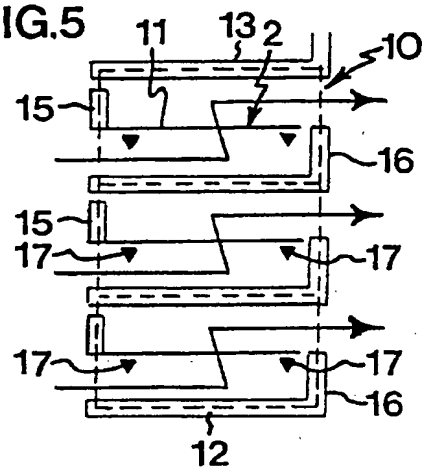


FIG.6

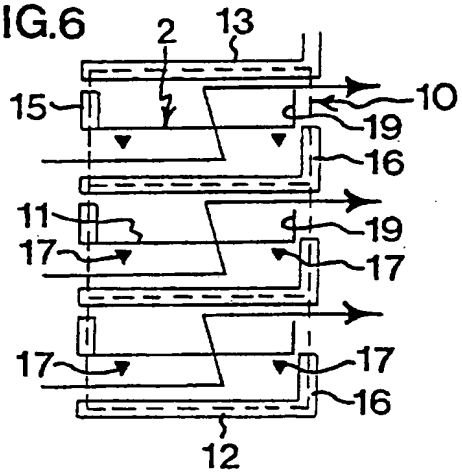


FIG.7

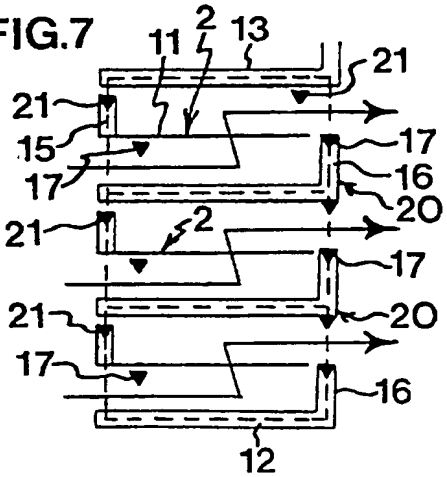


FIG.8

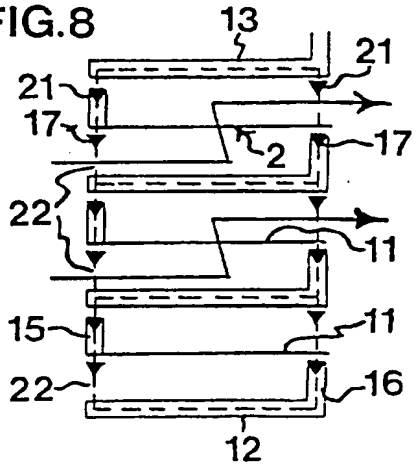


FIG.9

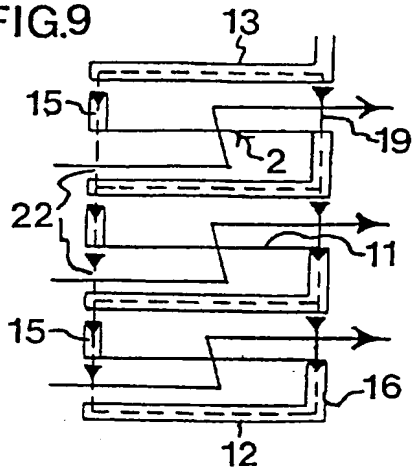


FIG.10

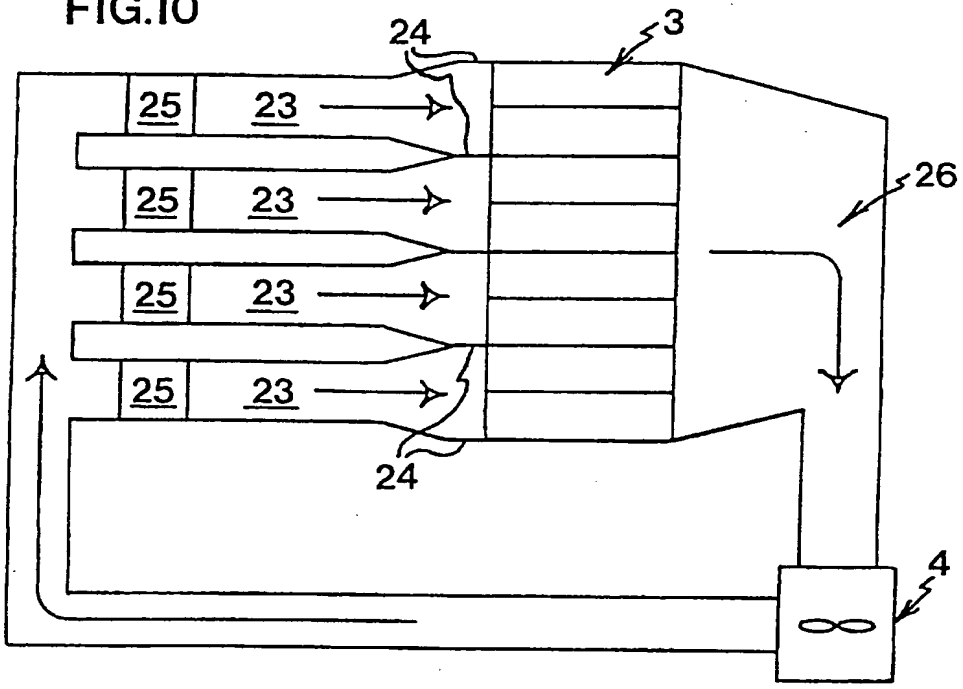
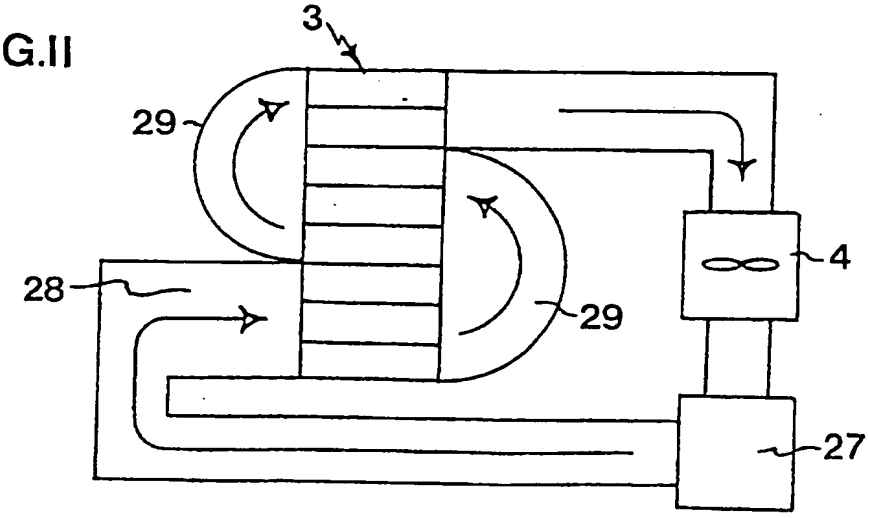


FIG.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01739

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F25D 25/02 // A23L 3/36
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F25D, B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search	Date of mailing of the international search report
14 April 1997	22 April 1997 (22.04.97)
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Inger Löfgren Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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International application No.
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